

WHAT IS CLAIMED IS:

1. A lower electrode contact structure of a semiconductor device, said structure comprising:

a semiconductor substrate having an active region;

an insulating layer disposed on said semiconductor substrate;

a contact plug extending through said insulation layer and electrically connected with the active region of said semiconductor substrate;

at least one layer of material, constituting an electrode support, extending upright along an outer peripheral edge of the top surface of said contact plug and protruding above the upper surface of said insulation layer; and

a lower electrode of a capacitor disposed on and extending contiguously along a central portion of the top surface of said contact plug, the electrode support, and a portion of said insulation layer that borders said electrode support.

2. The lower electrode contact structure of claim 1, wherein the electrode support comprises a first supporting layer extending upright along the outer peripheral edge of the top surface of said contact plug and protruding above the upper surface of said insulation layer so as to have radially inwardly and outwardly facing sidewalls, and a second supporting layer disposed on said sidewalls of the first supporting insulation layer.

3. The lower electrode contact structure of claim 2, and further comprising a sidewall spacer interposed between said contact plug and said insulation layer.

4. The lower electrode structure of claim 2, and further comprising an etch stop layer disposed on said insulation layer.

5. The lower electrode contact structure of claim 3, wherein the first supporting layer is an extension of said sidewall spacer.

6. The lower electrode contact structure of claim 4, wherein the thickness of said etch stop layer is identical to the thickness of said second supporting layer.

7. The lower electrode contact structure of claim 1, wherein the top surface of said contact plug is situated beneath the upper surface of said insulation layer.

8. The lower electrode contact structure of claim 1, wherein the top surface of said contact plug is situated above the upper surface of said insulation layer.

9. The lower electrode contact structure of claim 5, wherein the

first supporting layer is of the same material as said sidewall spacer.

10. The lower electrode contact structure of claim 5, wherein the first supporting layer comprises silicon nitride.

11. The lower electrode contact structure of claim 5, wherein the first supporting layer and the sidewall spacer comprise silicon nitride.

12. The lower electrode contact structure of claim 5, wherein the second supporting layer comprises silicon nitride.

13. The lower electrode contact structure of claim 6, wherein the etch stop layer is of a material identical to that of said second supporting layer.

14. The lower electrode contact structure of claim 13, wherein the etch stop layer and the second supporting layer comprise silicon nitride.

15. A method of forming a lower electrode contact structure of a capacitor, said method comprising:

forming a contact hole through a lower insulation layer disposed on a semiconductor substrate having an active region so as to expose the active region;

providing an insulating material on the sides of the contact hole to thereby form a sidewall spacer;

forming a recessed contact plug in the contact hole and which plug occupies only a lower portion of the contact hole;

removing a portion of the lower insulation layer until the resulting upper surface thereof is situated beneath the level of an upper portion of the sidewall spacer, whereby the upper portion of the sidewall spacer protrudes above the resulting upper surface of the lower insulation layer; and

subsequently forming a lower electrode of a capacitor on the recessed contact plug, on said portion of the sidewall spacer protruding above the upper surface of the lower insulation layer, and on a portion of the upper surface of the lower insulation layer that borders the contact hole.

16. The method of claim 15, wherein said forming of the recessed contact plug comprises:

forming a layer of conductive material on the lower insulation layer so as to fill the contact hole; and

selectively etching the layer of conductive material with respect to the lower insulation layer and the sidewall spacer so as to lower the upper surface of the layer of conductive material beneath the level of the upper surface of the insulation layer.

17. The method of claim 15, wherein said forming of the lower electrode comprises:

sequentially forming an etch stop layer and an upper insulation layer on top of the recessed contact plug, the sidewall spacer, and the lower

insulation layer;

patterning the upper insulation layer to form an opening aligned with the recessed contact plug, the sidewall spacer, and the portion of the upper surface of the lower insulation layer that borders the contact hole;

etching back the etch stop layer exposed by said opening;

forming an electrode material layer at the bottom and along the sides of said opening and on the upper insulation layer;

forming a protecting insulation layer on the electrode material layer so as to fill the opening;

planarizing the protecting insulation layer and the electrode material layer until the upper insulation layer is exposed; and

subsequently removing the remainder of the protecting insulation layer and the upper insulation layer.

18. The method of claim 17, wherein the sidewall spacer and the etch stop layer are formed of silicon nitride.

19. A method of forming the lower electrode contact structure of a capacitor, said method comprising:

forming a contact hole through a lower insulation layer disposed on a semiconductor substrate having an active region so as to expose the active region;

forming a recessed contact plug in the contact hole and which plug occupies only a lower portion of the contact hole;

subsequently providing an insulating material on an upper portion of the sides of the contact hole to thereby form a sidewall spacer;

removing a portion of the lower insulation layer until the resulting upper surface thereof is situated beneath the sidewall spacer, whereby the sidewall spacer protrudes above the resulting upper surface of the lower insulation layer; and

subsequently forming a lower electrode of a capacitor on the recessed contact plug, the sidewall spacer protruding above the upper surface of the lower insulation layer, and on a portion of the upper surface of the lower insulation layer that borders the contact hole.

20. The method of claim 19, wherein said forming of the recessed contact plug comprises:

forming a layer of conductive material on the lower insulation layer so as to fill the contact hole; and

selectively etching the layer of conductive material with respect to the lower insulation layer and the sidewall spacer so as to lower the upper surface of the layer of conductive material beneath the level of the upper surface of the insulation layer.

21. The method of claim 19, wherein the forming the lower electrode comprises:

sequentially forming an etch stop layer and an upper insulation layer on top of the recessed contact plug, the sidewall spacer, and the lower

insulation layer;

patterning the upper insulation layer to form an opening aligned with the recessed contact plug, the sidewall spacer, and the portion of the upper surface of the lower insulation layer that borders the contact hole;

etching back the etch stop layer exposed by said opening;

forming an electrode material layer at the bottom and along the sides of said opening and on the upper insulation layer;

forming a protecting insulation layer on the electrode material layer so as to fill the opening;

planarizing the protecting insulation layer and the electrode material layer until the upper insulation layer is exposed; and

subsequently removing the remainder of the protecting insulation layer and the upper insulation layer.

22. The method of claim 21, wherein the sidewall spacer and the etch stop layer are formed of silicon nitride.

23. The method of claim 21, wherein the sidewall spacer is formed of polysilicon and the etch stop layer is formed of silicon nitride.